MONOMOY AND ITS SHOALS.

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MONOMOY AND ITS SHOALS.

By the courtesy of Mr. F. M. Thorn, Superintendent of the United States Coast and Geodetic Survey, the Board is enabled to present a very able and interesting report, recently made to that department by Prof. Henry Mitchell, concerning *Monomoy and its Shoals*, — a copy of which has, upon request, been furnished for publication in this report.

Monomoy, it need hardly be said, is the long, narrow peninsula which projects southward from the shore of the town of Chatham, at the elbow of Cape Cod, and points towards Nantucket Great Point, which, in turn, stretches northward as if to meet it. Between these two points is the easterly entrance to Nantucket and Vineyard Sounds, through which, as Professor Mitchell says, "about 30,000 vessels pass annually, and occasionally 300 in a single day." In this great highway of commerce, around Monomoy Point and between it and Great Point, lie the Shoals of which the report treats.

The purpose of the report is to show the *changes* — the shifting of position and growth in volume — of Monomoy and its Shoals during the last century. The discussion of the data available for a comparison of their former with their present location and bulk, and the methods of investigation and deduction by which the results stated are arrived at, are fully given in the report, and are marked by the scientific knowledge, skill and acumen for which the writer of the report is distinguished.

The results are surprising, and seem to furnish just occasion for alarm. "The present aspect of the case," says Professor Mitchell, "is very threatening to navigation." It

is not proposed, however, to anticipate the more full and satisfactory statements of the report itself.

A map accompanying the report of Professor Mitchell is appended to this report, and presents to the eye by distinctive colors the comparative position and dimensions of Monomoy and its Shoals as shown by a chart based upon a survey made by Capt. Paul Pinkham in 1784, the accuracy of which is vindicated by Professor Mitchell, and as shown by the United States Coast Survey chart issued in 1885.

Another map, also received with the report in question and appended to this report, shows in like manner the increase of "*Handkerchief Shoal*" between the years 1853 and 1874–75, by means of a comparison of the coast surveys made at those dates respectively.

MONOMOY AND ITS SHOALS.

BY PROF. HENRY MITCHELL.

This peninsula, and the group of Shoals about it, present dangers that affect the commerce between the States to a greater degree, perhaps, than any other obstructions; for here, at the eastern entrance to Nantucket and Vineyard Sounds, pass about 30,000 vessels annually, and, occasionally, 300 in a single day, the maximum of the year. These 300 vessels average 200 tons measurement, giving a total of 60,000 tons, and represent, with cargo, *three millions of dollars.*

These vessels not only run the gantlet among these natural dangers, but *they endanger each other* by crowding into the fairways. The principal avenue, Butler's Hole, has only half the width that it had a century ago, and its course has of late years very materially changed.

Every foot of width, where safety is assured, has a value; and, if the limits of the Shoals could be accurately defined, there would be a great reduction in the real danger, and — most of all — in the *fear of danger*, which delays the fleet in thick weather. In the measure that we can furnish the coaster with accurate charts and marks of this locality, we reduce his danger and his fears which tax the community.

The real source of trouble is the constant shifting of these Shoals, and their growth. We speak within the truth when we assert that these Shoals have doubled their volume in the last century, and that they have moved a mile in the average. The worst of it is that the movement is very far from uniform in rate or directions for different members of the group.

This neighborhood was designated by Champlain (1605) "*Cap Batturier*," conveying the impression by this name (and the context in his narrative) of a projecting region of breaking flats. At the present rate of building, the dry land of Monomoy could scarcely

have been half the present length at the time of Champlain; and, if half the bulk, it must have been submerged.

The present aspect of the case is very threatening to navigation. It looks as if a continuous breaker might extend from Monomoy to Nantucket on the summit of the circus that is formed by Pollock Rip, Great Round Shoal and Great Point Rip, with their connections. The present broken wall has material enough in it to close the ship navigation, if this material should be strewn along more uniformly by some great storm, so as to connect more intimately the chain of shoals. Moreover, there is plenty of new material supplied from the caving down of the Cape Cod shore. This caving has been very active of late years, and forms the theme of reports in Appendices to the Annual Reports of the Coast Survey for 1871 and 1873. The beach in front of the town of Chatham began to break up in 1871; and Professor Peirce, then Superintendent, ordered special surveys, which were executed by Assistant H. L. Marindin, and formed the subject of reports by myself.

The earliest chart of this neighborhood, based upon anything like a regular survey, seems to be that of Capt. Paul Pinkham, made at the time that the present Light-house was being built upon Great Point Nantucket, in 1784. There are plenty of earlier charts, and there are sailing directions as far back as 1707; but the Paul Pinkham chart, on the whole, furnishes the first reliable testimony relative to the location of the Shoals at the entrance to the Vineyard Sound. I beg leave to offer an analysis of this testimony in detail, because of its importance, and because I fear that the chart of which I speak is likely, otherwise, to be confounded with a later one by the Blunts, assuming to be "Surveyed by Capt. Paul Pinkham," which is singularly out in its longitudes and in its distances.

The following appears upon the chart which I have used as my base of comparison: —

A Chart of Nantucket Shoals surveyed by Capt. Paul Pinkham.

Boston. Published and sold by Wm. Norman, No. 75 Newbury St., February 16, 1791.

To all whom it may concern:

As there never has yet been published an accurate chart of Nantucket Shoals,

These are to certify that, when the Light-house was building on Nantucket point in 1784, this survey of the Shoals was made from the lantern (an opportunity never before had for so valuable a purpose) by Capt. Paul Pinkham and others, by the help of the best compasses and instruments that could be procured; and it has been proved by experience to be the most accurate chart ever offered to the public of those dangerous Shoals (which are a terror to all navigators), which has been run by

with greatest safety, and is fully approved; and that the publication of this chart, from its accuracy, cannot fail to be greatly beneficial to all navigators who may fall in with said Shoals, is the judgment of us, [signed by] Jno. Cartwright, Jos'h. Chase, Dan'l Coffin, Nath'l Barnard, Jas. Backer, Wm. Coffin, Alex. Coffin, Jun., Thos. Delano.

Nantucket, September 1, 1790.

The many surveyors who have attempted the survey of the Island of Nantucket, with the Shoals around it, and those charts have been published, have from experience proved very incorrect and erroneous; more particularly the Shoals which, lying at so great a distance from the land, have hitherto been laid down from information only. From hence has arisen great errors and inaccuracies in the various charts published of those Shoals.

On considering their dangerous situation, and the dread they are to all navigators who frequent the coast, as well as the great utility of a correct chart, I have been induced to use my best endeavors to obtain a new and accurate survey of the Shoals eastwardly of the Island, being taken from the Light-house on Nantucket Point in 1784, which eminence afforded a large and distant prospect of the Shoals, and from which their true bearing was had with precision and certainty. I hereby certify that the chart hereunto annexed, having been carefully examined by warrantable pilots and navigators, and run by for some years with safety, is fully approved and by them certified. [Signed by] Peleg Coffin, Jr.

Nantucket, September 1, 1790.

The scale of this chart is about 1 : 137,780. It is the property of the Nantucket Athenæum.

It will be observed from the foregoing, that the claim of accuracy particularly applies to the region seen from the Light-house, which is plotted on this old chart in latitude 41° 22′, longitude 70° 00½′. It is the same Light-house that now stands, and is found, by latest survey, in 41° 23′ 24″ of latitude, and 70° 02′ 45″ of longitude. The former determination, on the Paul Pinkham chart, was, then, 2¼ miles too far to the east-south-east. This error, however, need not concern us if we confine our inquiries to objects within sight of the Light-house; and, first of all, we must seek those that have not changed, in order to orient ourselves.

From Matthew Clark's chart of the neighborhood, endorsed by Osgood Carleton for the Boston Marine Society, the variation in the compass, at that time, seems to have been 6° 45′; and, as the Paul Pinkham chart is evidently adjusted to the magnetic meridian, we have corrected for variation (as finally ascertained to be about 6½° west) in the following bearings: —

"Bishop and Clarks" Rocks, on Paul Pinkham's chart, lie 15¼

nautical miles north 39¼° west (true) from Great Point. Bishop and Clerks, on the most recent chart, lies 14¼ nautical miles north 39¼° west of Great Point Light.

The distances are measured from the old chart, not by its scale, but by minutes of latitude. I would remark here that the Paul Pinkham chart is a pretty good projection, with ratio of 1 : 1.3 for longitude and latitude divisions; but the *scale of miles* seems to be minutes of longitude.

There is, upon the north-eastern portion of Tuckernuck, a sort of lagoon, at the head of which is quite a hill, upon which there was, at the time of Paul Pinkham, and still is, a group of houses. This hill, as represented upon the Coast Survey charts, lies west 30° south from Great Point Light, distant 10¾ nautical miles. Upon Paul Pinkham's chart, the head of the lagoon bears west 29½° south, distant 11 nautical miles. The lagoon is known as East Pond, and the hill that rises at its head is a very conspicuous landmark.

These three points, *Bishop and Clerks*, *Tuckernuck* and *Great Point Light*, are all that we can feel sure of as remaining unchanged.

Great Round Shoal. — If we draw a circle through the three shoalest soundings upon the Coast Survey chart, we find its centre north 55° east from the Great Point Light-house, distant 7¾ miles. On the Paul Pinkham chart, it is represented by a circular line of dots, the centre of which is north 60¾° east of Great Point Light, 7½ miles distant.

Little Round Shoal. — The shoalest water lies north 39½° east of Great Point Light, upon our most recent charts, distant 8 miles. Upon Paul Pinkham's chart, it is indicated by a circle of dots, the centre of which is north 40¾° east from the Light, distant 7 miles. This shoal is not easily distinguished from the *Stone Horse*.

"*Broken part of Pollock Rip*" lies north 37½° east, 11½ miles from the Light, on the Coast Survey chart, and north 35½° east, 11⅞ miles, on Paul Pinkham's chart. This is rather beyond the range of vision from the Light-house, except for a wreck, and hard to distinguish, the shoals being numerous.

Stone Horse. — The middle of this shoal, as well as can be determined, lies about in the same direction upon old and new charts, — north 22¼° east from Great Point Light. Its distance, according to Paul Pinkham's chart, was 8½ nautical miles. It is now 7¾ miles; that is, the shoal has moved about three-quarters of a mile towards the Light.

Handkerchief Shoal. — This shoal has very much increased in size, and worked or extended downward. The least depth is the same ("4 feet") now as upon Clark's map of 1798; but this figure

lies about one mile further from Great Point Light on Clark's chart than upon our own. The southern point of the shoal is given $8\frac{3}{5}$ miles north 2° west from Great Point Light, by Pinkham, while by Clark it is $7\frac{1}{2}$ miles due north, and upon the recent Coast Survey chart $6\frac{1}{3}$ miles north $7\frac{3}{4}$° west. The northern or north-eastern portion of the shoal has not essentially changed, being the same for Pinkham, Clark and the Coast Survey; but the growth southward has exceeded one mile in the past century.

Upon both of the old charts (Pinkham's and Clark's), the sailing course for the "North Channel" was laid down north of the Handkerchief, and ran across what is now dry land near the present Monomoy Light.

Clark's representation of Monomoy indicates a great extent subject to overflow, so that it is difficult to make comparisons between it and other plottings.

Butler's Hole. — This most frequented channel was about $1\frac{9}{10}$ miles wide upon Pinkham's chart, one mile on Clark's, and little better than a half-mile at the time of the most recent surveys. As might have been expected, Butler's Hole has increased in depth as it has lost in width. We find nearly 20 fathoms on the site where the old charts gave 15 as the maximum depth. The present maximum depth is $23\frac{1}{2}$ fathoms.

Before entering upon the more modern history of this region, we must call attention to what we may designate as the *deep hole*, indicated by the sounding of 24 fathoms upon Paul Pinkham's chart. This sounding is plotted $7\frac{1}{2}$ nautical miles north $71\frac{3}{4}$° east of Great Point Light. Capt. McBlair, in 1849, found $21\frac{3}{4}$ fathoms at a distance of 6 miles north $79\frac{3}{4}$° east, and Capt. Brownson, at the margin of his survey of 1883, gives 20 fathoms and no bottom 7 miles north $77\frac{1}{2}$° east, of Great Point Light.

There seems to be no doubt that a *gully* of considerable extent exists, which our printed chart does not properly represent; and it is believed that this gully is a permanent feature, notwithstanding that our bearings differ from Paul Pinkham's very largely. It must be borne in mind that the bearings of *breaking shoals* could be accurately taken from Great Point Light tower; but a *deep hole* makes no sign.

This gully lies so near the proper track of the South Channel fleet, that its careful representation upon the chart would be a valuable guide to navigation; while its absence from the chart, or entirely inadequate rendering, provides for disaster. Some vessel standing in from seaward in thick weather, may happen to cast her lead in this deep place, and, believing herself outside of all the shoals, sail on to her destruction.

There is reason to believe that Great Round Shoal and this gully are to be found now just where they always have been. The sailing line on Paul Pinkham's chart of 1784, if plotted upon our own chart, lies very near the southern slope of this gully, and between it and our most recent sailing line. But why this gully should not fill up, in this region of strong tidal currents laden with sand, is a mystery. It might be worth while to take some current observations, and ascertain if a *resultant* occurs here, not elsewhere developed.

Monomoy Point. — This is well defined on Desbarres' chart of 1777, and on Pinkham's of 1791; but, on Matthew Clark's chart of 1798, it is represented as if *awash*. The distances across from Great Point to Monomoy are

1777,	On Desbarres'	Chart, . .	14	nautical miles.	
1784-91,	" Paul Pinkham's	" . .	$11\frac{1}{4}$	"	"
1798,	" Matthew Clark's	" . .	$10\frac{1}{2}$	"	"
1868,	" U. S. Coast Survey	" . .	$9\frac{1}{4}$	"	"

Matthew Clark's chart only assumes to be a correction of Desbarres', while Paul Pinkham's was from a new survey.

There seems always to have been a shoal off the extreme point of Monomoy, known as "Egg Island" when dry. This shoal has sometimes attached itself to the end of Monomoy, but oftener has been separated by a deep *slough* channel. If we ignore the slough channel that now separates the point of Monomoy from the *Shovelful Shoal* (the reappearing Egg Island in an advanced position), we reduce the distance across from Great Point to less than 9 nautical miles (1875).

It should be noted here that Great Point Nantucket has lost, by fits and starts, considerable length. Paul Pinkham found the extreme point, in 1784, over 3,000 feet beyond the present Light-house, then in course of construction; Prof. Henry L. Whiting's topographical survey of 1846, gives this distance 1,900 feet; and Assistant F. D. Granger, on his hydrographic sheet of 1874, places the point (by a signal as near as possible to the high water breaker) about 1,600 feet from the Light-house. *We have every reason, then, to believe that the dry land of Monomoy has extended southward two miles* during the past century.*

* There is a mysterious chart in the archives of the Coast and Geodetic Survey, entitled "A Chart of George's Bank, including Cape Cod, Nantucket, and the Shoals lying on their coasts, surveyed by Capt. Paul Pinkham," and "published by Edmund M. Blunt, 1797." This chart, ostensibly six years later than the "Chart of Nantucket Shoals" (which we found so valuable), is comparatively absurd. It is a whole degree out in longitude, and it gives for the distance from Great Point to Monomoy, sixteen minutes of latitude; and yet the bearing and distance of George's Shoal were more nearly correct than upon any previous chart. Its scale is about 1 : 400,000.

The first survey of Monomoy made by a professional topographer, was that of Mr. Charles O. Boutelle, then attached to the Trigonometrical Survey of Massachusetts, in 1840. At that time the Point lay 2,681 feet south, 3,837 feet west, of the Light-house then standing.*

In 1853, Assistant S. A. Gilbert of the Coast Survey, made a plane-table survey, and found the extreme point of Monomoy 2,821 feet south, 3,542 feet west, of the old Light-house referred to by Mr. Boutelle. The first twelve to thirteen years of authentic history only advanced this point about 140 feet.

The next survey was by Assistant C. T. Iardella of the Coast Survey, in 1856, when the extreme point was found to be 3,180 feet south, 3,906 feet west, of the "old Light-house," — showing an advance of 509 feet south-west in three years, or at the rate of 170 feet per annum.

Again, the point was located by the survey of Assistant P. C. F. West of the Coast Survey, in 1868, 4,851 feet south, 5,266 feet west, of the same "old Light-house," — showing an advance south-westerly of about 2,123 feet in twelve years, or about 175 feet per annum.

Finally, we have the plane-table sheet of Assistant C. H. Boyd of the Coast Survey, executed with the intent to complete the history to the present time, June, 1886; and we find the point 5,266 feet south, 5,151 feet west, of the site of the old Light-house, — showing a recent advance of about 22½ feet per annum, nearly south. The growth of the point is again slowing down; and Mr. Boyd's map shows that deposit has been arrested elsewhere *en route* from the north. It would seem that the material torn from the Chatham shore travels down the beach, or near to it, and adds itself to the point of Monomoy in unequal masses, at unequal intervals of time.

As far as we are advised, the sands move from the north, under the action of the *ground swell* which sets on from the north-east. It is the same at this entrance to Vineyard Sound, as at the entrances of Delaware and Chesapeake Bays; the *shoals protrude and advance from the north side.* Of course, at all such entrances, the flood tidal currents sweep in along the outside shores, and bear with them a great load of silt supplied by the breakers, so that the

* See Capt. Boutelle's Report, addressed to Superintendent U. S. Coast and Geodetic Survey, June 16, 1886, appended.

Capt. Boutelle's testimony against the map made by John G. Hale, in 1831, rules it out of court; but I may be allowed to state that, upon that map, the Point is represented as about 1,650 feet south of the Light, and the *Powder Hole Harbor* is absent. There is no doubt, in my own mind, that the testimony of the old people on Cape Cod is correct in ascribing the first creation of the Powder Hole to the first half of this century. We have witnessed its destruction.

resultants are towards the bay near the coast; but this movement is usually just as conspicuous on one side as on the other of the entrance.

Mr. Boyd found the Shovelful Shoal showing a dry spot for two hours at low tide. This has been dry before, but our hydrographic sheets have usually given one foot at mean low tide. The summit of this shoal is now about 2,300 feet further to the south-west than it was in 1853, but the point of Monomoy has gained upon it 877 feet. Of course, if this gain continues, a sudden annexation may be expected. It seems probable that this shoal advances more slowly than Monomoy Point, because in deeper water. The central point of the dry Shovelful is now 9,617 feet south 36° 41′ west (true) from the old Light-house site.*

The discrepancies of the measures of Monomoy from land surveys, cannot be attributed to any want of definition, or to differences in the height of the tide. On sandy shores exposed to ocean waves, the *strand* (that is, the belt left bare when the tide is out) is very narrow, and of nearly uniform width for tides of equal range. This is often true irrespective of the ocean depths in the neighborhood. It is quite otherwise as regards inside beaches, — those along the margins of sheltered basins or harbors, — where the strand is often broad, and always irregular, because only the continuation of the *bed-slopes*.

The point of Monomoy has always been bold, or "*steep to*," as the sailors say.

Let us turn now from these measures of dry land to the hidden dangers that lie beneath the sea. These are *dunes*, that creep upon the track of our commerce, and grow upon the channels, to become more and more sources of distress every year; and the most remarkable of these — although not the most dangerous — is

The Handkerchief Shoal.

From a glance at our most recent survey, one would say that this shoal is shaped like a pear with stem downward. It is, in a very general sense, a sector-like figure with radius of $3\frac{1}{4}$ nautical miles and 36° *flare*. Closer examination, however, discovers that it is not symmetrical, but consists of three lobes, representing, as I think, three different periods of growth. The most northern lobe, which is the largest now, is the oldest. We find it upon Paul Pinkham's chart in the form of a horseshoe opening directly west. It was then about half the size of the present northern lobe, as

* The old Light-house was 182 feet north 46° 30′ west (true) from present Light-house.

limited by the 12 feet curve, or less than a third of the whole shoal as now similarly limited.

The area of this shoal, as defined by the 18 feet curve, increased from 9,888,870 square feet in 1853, to 12,636,672 in 1875; and the southern point advanced into the sound 3,400 feet, or over one-half of a nautical mile (34 seconds of latitude). The bulk of this shoal, in 1853, was 12,543,759 cubic yards; in 1875, it had increased to 19,175,835 cubic yards; and, in this interval, its centre of gravity had moved 3,956 feet south 2° 55′ east (true).*

It has been possible to give the above concise statement relative to the Handkerchief Shoal, because, as an isolated obstruction in the track of one of the largest fleets in the world, it has been repeatedly examined and surveyed.

I am not aware that this little chapter in the physical history of these Shoals has ever before been attempted; but I feel great confidence, having been assisted by Mr. H. F. Bothfeld, one of the best experts met with in my long professional experience.

I hope to perfect my diagnosis of this case by other papers to follow.

Very respectfully yours,

HENRY MITCHELL,
Coast and Geodetic Survey.

Report of Capt. Charles O. Boutelle concerning the earliest Topographical Survey of Monomoy.

U. S. COAST AND GEODETIC SURVEY OFFICE,
WASHINGTON, D. C., June 16, 1886.

F. M. THORN, *Superintendent U. S. Coast and Geodetic Survey, Washington, D. C.*

SIR:— I return herewith the papers submitted by Assistant Mitchell, on the subject of Monomoy Island, south of Chatham, Mass.

I recognize the smaller tracing, sent by Mr. H. F. Walling, as copied from a large manuscript map which I assisted in making. I also recognize it as a correct copy of a plane-table survey made by me of the island of Monomoy, in November, 1840. I checked the survey by several triangulation points upon the island, determined by me for temporary use, by "three-point" method.

At the time of my survey, the "Powder Hole" harbor, near the Light-house, was a place of resort for fishermen, and a harbor of refuge for small vessels.

By spacing upon the tracing, I find that the southernmost point of Monomoy Island, in November, 1840, was 2,475 feet or 24.″4

* See Sketch by Mr. H. F. Bothfeld, herewith enclosed [and appended to this Report].

south, and 3.836 feet or 50."5 *west*, of Monomoy Light. The Coast Survey position of the same light is given in Coast Survey Report for 1851, page 189, as latitude 41° 33′ 32."79, longitude 69° 59 18."98.

The "faint indication of a triangulation point" upon Mr. Walling's tracing, is undoubtedly that of the Light-house. He gives the squares enclosing it. These count from the zero point of the section, and are four inches upon a side, or, upon the scale of 200 rods to an inch (1 : 39,600), each side is 800 rods or 13,200 feet long.

In the printed tables of the Massachusetts Trigonometrical Survey, Section V, page 71, Monomoy Light-house is given as $202.380\frac{37}{100}$ feet south, and $191.375\frac{34}{100}$ feet east, of the zero point of the section. The *north* side of the square enclosing the Light is, therefore, the 15th south of zero, or $13{,}200 \times 15 = 198{,}000$ feet south; and the *east* side is also the 15th, or 198,000 feet east of zero.

The position of the Light-house in the square is, therefore, $4.380\frac{3}{100}$ feet south of its north side, and $6{,}624\frac{69}{100}$ feet west of its east side. These quantities, spaced upon the tracing, agree so closely with the triangulation point marked by Mr. Walling, as to assure its identity with the Light-house of 1840.

The necessity for my survey of Monomoy Island, arose from the grossly inaccurate character of the map of Chatham made by Mr. John G. Hale for the town authorities in 1831. This person was employed by contract with many towns in eastern Massachusetts to make maps which could be returned to the Secretary of State, under the act requiring each town to make and return a map of its territory upon an uniform scale of 100 rods to an inch. Mr. Hale's maps were all very neatly drawn, and were all very inaccurate. Many were only sketches without a survey. So far as I can recollect at this distance of time, I was informed that Mr. Hale never visited Monomoy Island, but copied some older map or chart. At any rate, the case was so flagrant an evasion of the law, that the "Selectmen" of Chatham furnished me, at their expense, with men and transportation required to make the survey.

The large tracing sent by Mr. Walling, represents Mr. Hale's map now on record in the State House at Boston.

Yours respectfully,

C. O. Boutelle,
Assistant C. & G. Survey.